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SOME PROBLEMS IN SELECTING DATA COMMUNICATIONS LINKS,(U)
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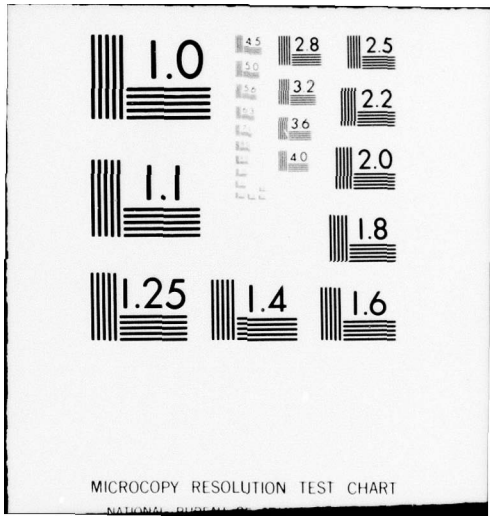
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FOREIGN TECHNOLOGY DIVISION

SOME PROBLEMS IN SELECTING DATA COMMUNICATIONS LINKS

By

Romuald Białobrzeski and Władysław Grabowski

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Some Problems in Selecting Data Communications Links

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For about ten years there has been extremely rapid growth in a new branch of telecommunications — data communications, which is increasingly becoming a telecommunications service. Data communications is the branch of science and technology which is occupied with problems of remote collection, transmission, and storage of information, its presentation and processing, and the construction of hardware and systems.

It should be emphasized that this concept refers primarily to the direct exchange of data between automatic equipment, computers, and devices of all kinds, without human participation. With the increasingly common use of computers,the demand for this type of transmission will grow rapidly. There will have to be a general expansion of telecommunications equipment and an improvement in its

operating reliability and flexibility.

The purpose of this article is to draw attention to some problems associated with selection of data links from the point of view of efficient transmission speed, i. e., the quantity of information per unit time transmitted and received between two data-transmission facilities. In order to achieve a high level of transmission at an efficient speed on the links between network junctions, it is necessary to select the basic links and monitor their parameters during operation. Here "basic links" means telecommunications links of a general-use network realized in any form, supplemented with the appropriate equipment and utilized for data transmission. In this study we shall try to point out some trends and methods in research being conducted by leading firms or scientific centers which are occupied with problems of data transmission.

The terminology in this field is still not established, so some definitions and names are proposed and may be corrected in the future.

Methods of monitoring and selecting data-transmission links

There are three methods of monitoring basic links: static, dynamic, and correlative.

The static method [8] involves measurements under conditions simulating actual transmission of data, with the measured links disconnected from the functioning system. Research is generally done on a discrete channel (link + modems) or on a link by itself (measurement of so-called conventional parameters).

The dynamic method [3,4] depends on real-time monitoring and se-

lection of a link by a system. If a certain number of transmission repetitions is exceeded, a faulty link condition is signalled, a test for preservation of the transmission appears, and transfer to a reserve link occurs. This is not a satisfactory solution, since it considers only an extreme case, whereas it is possible to have a transmission along a line which is not particularly good , so long as an arbitrarily established number of transmission repetitions is not exceeded.

The "correlative" method [5] is based on the calculation of the "degree" of correlation between the conventional parameters of a link and the probability of an error appearing in the transmission of data; this is taken as the basis for defining the condition and serviceability of the link. This method is advantageous because it studies the condition of a link during an actual transmission by measuring conventional parameters. A drawback is the arbitrariness of the "degree" of correlation between the probability of error and the value of the conventional parameters.

Supervision and monitoring of data communications links

The problems of measuring the parameters of data transmission links have not as yet been widely discussed in either foreign or domestic literature. The information which has been encountered deals with very general problems and does not contain details about hardware and software solutions. For example, in a description of interjunction connections of the American ARPA network [7] it has been stated that the most effective method is detection of a malfunctioning link and transfer of correspondence to a reserve link.

These relationships involve two links with a transmission speed of 80 kbit/s, with one of the links always regarded as a reserve link. In the description available there is a lack of information on methods of switching a link and on criteria for data transmission links.

One example of a solution to the problem of monitoring and selecting inter-junction relationships is an IBM development based on the hardware and software of the 3705 Communication Controller [9]. This unit appears mainly in remote-processing networks created by IBM, although its flexibility qualifies it for the role of a junction in a computer network. Here a data-communications junction refers to a telecommunications junction servicing data-communications facilities and generally provided with processor, mass memory, and peripheral equipment.

An interesting solution has been used in the computer research network Distributed Network DCS, planned at the University of California. This network is characterized by a high level of reliability, among other things. It is a ring network and uses PCM channels as links. The ring consists of elements which are each constructed from three independent telecommunications links. The first link is used for transmitting, while the second link is a control link which becomes active when errors occur in the transmission. The occurrence of errors automatically causes the data stream to be switched to the third link, which is a reserve link. Transmission on the first link resumes after the source of the errors is localized and eliminated.

References to another approach for problems of evaluating data

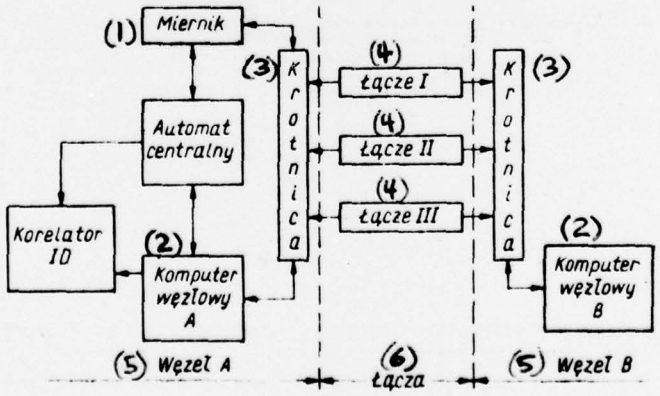
transmission quality can be found in Soviet literature [5, 6]. There has been prolonged theoretical and experimental work aimed at finding a correlation between the element error rate and the signal parameters on the receiving side in transmission using binary modulation of frequency (FSK). With this type of transmission the main source of errors on an actual link is short interruptions and pulse disturbances, which can be observed in the form of brief fluctuations in signal envelopes. The measure of these fluctuations can be taken as a criterion for evaluating transmission quality, provided the correlation is known between this measure and the error rate. In the general case it is practically impossible to determine such a correlation for a random model of disturbances on a link. However, this correlation has been established for the specific case of long-distance telephone channels divided into linear multiplex telephone paths. On the basis of results from extensive work, Soviet designers at the Kiev Branch of the TsNIIS [Central Scientific Research Institute of Communications] have developed the IAPP-2 measuring device, which makes it possible to measure the error rate according to the analog signal parameters. More detailed information, with consideration of patent conditions, will be available after production gets under way.

Research being done in Poland on data transmission links involves commonly-used analog measures of link parameters. Although existing apparatus permits measurement of certain parameters of data transmission links, the process of monitoring and selecting the links needs to be automated.

This trunk line is associated with, among other efforts, work

being carried out at the Telecommunications Institute of Warszaw Polytechnic, where there is a project [8] for a device to monitor and select basic links interfacing with a junction computer, which is used in a data transmission system as an information-switching junction. The purpose of this device is to measure links between junctions, evaluate the condition of the links (on the basis of a specified criterion), and classify the links as suitable or unsuitable for transmission. Cooperation with a junction computer involves the simulation of cooperation procedures at the interface between the device and the computer channel.

The monitoring and selection unit (UKW) is designed for operation with a computer of the Singer S-10 type. The device is capable of being easily adapted for operation with other types of computers, regardless of their storage capacity. The block diagram shows a UKW for automatic measurement and selection of basic links for activity between junctions. It is acknowledged that the optimum number of links assigned to transmission between junctions is three unswitched links.



Block diagram of UKW equipment for automatic measurement and selection of basic links in activity between junctions
1 – measuring instrument; 2 – junction computer; 3 – terminal; 4 – link; 5 – junction; 6 – links

The operating principle of the equipment is as follows: The junction computer at junction *A* is connected directly to a terminal (switching system), which makes it possible to use one of three links of the measuring instrument for transmission; access is provided to one link held in reserve. Overall control is by an automatic central unit, which also ensures communications with the computer. Junction *B* contains a terminal to connect the computer of junction *B* to the proper link and also to set up a loop for measured links. The links are measured in the loop. This makes it possible to use only one measuring instrument in the entire arrangement. It should be pointed out here that the terminal in junction *B* is controlled without an extra connecting path between junctions. Access to the link at the request of the computer in junction *A* is immediate. Links not used in a certain period for correspondence are measured cyclically, and their condition is signalled at the same time. The operating cycle is monitored by the control system. The computer in junction *B* cannot send a request for a link change through the terminal in junction *B*. This is only a receiving terminal controlled from junction *A*. The automatic central unit also provides a visual link-condition signal for the system operator at junction *A*.

Final remarks

The development of a data communications network is decided not only by technical problems but also by economic considerations. In view of the high cost of leased links, network development is showing a tendency to widespread use of switched links. A fundamental problem in switched networks is quality control of the connections

passing through an exchange. In planning the system it is necessary to allow for cooperation with exchanges of different systems and also for the influence of the connection failure rate [12] and the hardware efficiency of the exchanges. In certain cases, when switched links are used, there is a risk of receiving a busy signal, which blocks transmission. Furthermore, the reliability of the links may suffer. Where a high level of accessibility is required, the data communications network should contain reserve transmission routes. Future data communications networks may employ both switching of links and switching of information (packets). A fundamental element of this process will be electronic switching systems which are already common, making it possible to eliminate some of the defects of exchanges already in operation.

Irrespective of the method of switching, the development of traffic automation and the anticipated growth in demand for data transmission services are creating a need to design systems [13] and automatic measuring devices [8] which make it possible to monitor and supervise the component links of data communications networks. Those systems which allow the use of computer technology in the processing of test results permit objective classification of links as to reliability and increased data-transmission capacity and speed.

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